

**Development of Dissolved Oxygen (DO) Criteria and Assessment Protocols  
to Support Fish and Wildlife Propagation in Louisiana Waters  
Based on Ecological Regions (Ecoregions) and Water Body Types**

Louisiana Department of Environmental Quality  
and  
Environmental Protection Agency Region 6  
Water Quality Protection Division

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## **I. Introduction**

Section 101(a)(2) of the Clean Water Act (CWA) states “it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water be attained....” In an effort to achieve the national goal, all Louisiana streams were originally designated for fish and wildlife propagation use, and supporting criteria for dissolved oxygen were assigned based on national guidance for warm water fisheries (USEPA, 1986; May 3, 1972 letter EPA - A. Busch, Regional Administrator to R. Lafleur, Louisiana Stream Control Commission.).

Fish and wildlife propagation is defined as “...the use of water for aquatic habitat, food, resting, reproduction, cover, and/or travel corridors for any indigenous wildlife and aquatic life species associated with the aquatic environment. This use also includes the maintenance of water quality at a level that prevents damage to indigenous wildlife and aquatic life species associated with the aquatic environment and contamination of aquatic biota consumed by humans” (LAC 33:IX.1111). Currently, the designated use of fish and wildlife propagation applies to most water bodies throughout Louisiana, and except where site-specific dissolved oxygen (DO) criteria have been developed, the criterion for supporting the fish and wildlife propagation use is a minimum of 5 mg/L in freshwaters and marine waters, and a minimum of 4 mg/L in estuaries (LAC 33:IX.1113.C and 1123, Table 3).

When a state wishes to adopt a use (or a subcategory of a use) which is less stringent or requires less stringent supporting criteria, federal and state regulations provide a mechanism for change (40 CFR § 131.10(d), 40 CFR § 131.10(g), 40 CFR § 131.10(j)(2) and LAC 33:IX.1109.B.3). That mechanism is a Use Attainability Analysis (UAA).

According to the regulations, a UAA is defined as “a structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological, and economic factors (See 40 CFR § 131.3(g) and LAC 33:IX.1105). The UAA process is described in 40 CFR § 131.10 and LAC 33:IX.1109.B.3. It entails the methodical collection of data that is then scientifically analyzed and summarized and used to establish site-specific uses and criteria.

For many Louisiana water bodies, the natural, physical conditions (such as lack of slope and re-aeration potential) prevent attainment of the current nationally-based DO criteria. Studies conducted in Louisiana by the United States Environmental Protection Agency (EPA), LDEQ, and Louisiana State University (LSU), and in other states such as Texas and Arkansas, have indicated the adaptivity and abundance of aquatic life in areas that naturally contain less than 5 mg/L of DO (LDEQ 1996b, 1998, 1999; DeWalt 1995; Arkansas DPCE 1987; Crowe and Bayer 2005). Because incorrect criteria can result in erroneous use impairment decisions that impact a multitude of programs (e.g., total maximum daily load determinations, wastewater permitting, implementation of best management practices to reduce non-point source pollutant loads), it is critical to establish the appropriate and protective DO criteria that will be used to assess the support of fish and wildlife propagation in these regions.

One option suggested by EPA is for states and tribes to establish water quality criteria via a framework of ecological regions (ecoregions) (Gallant et al. 1989). LDEQ supports this approach as the most reasonable and scientifically defensible method to address the natural conditions present in many of Louisiana's water bodies and the development of DO criteria to support the attainable fish and wildlife propagation use. In the early 1990's, LDEQ conducted extensive ecoregional studies on wadeable streams in four Louisiana ecoregions. The data collected during those studies have been utilized in previous, site-specific UAAs. However, the ecoregion approach is applicable to all water bodies of a given waterbody type within an ecoregion as a way to develop supporting criteria. The following sections of the document describe:

- The ecoregional approach to developing dissolved oxygen criteria
- Louisiana ecoregions and water body types
- Reference site selection criteria and process
- The chemical, physical and biological data to characterize the reference condition for each ecoregion and water body type
- The analytical procedures used to establish dissolved oxygen criteria
- Procedures to integrate in-situ or profile and continuous monitoring dissolved oxygen data for water quality assessment purposes

The ecoregion approach described in this document provides a "framework" for revising criteria in Louisiana and represents the basic elements of a UAA as presented in EPA's - *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses* (USEPA, 1983). EPA encourages the continued development and use of other scientifically sound approaches, methodology, and tools that meet these basic elements. Likewise, as more data are collected, tools and methods are refined, and lessons are learned, enhanced protocols for revising criteria and assessment protocols may be implemented. Such additional data or documentation may include, but are not limited to, refinements of ecoregion boundaries, reference conditions, seasonality, water body types, or analytical procedures. These factors will be fully justified and documented in the resulting UAA reports and associated technical documentation and assessment methodologies as appropriate.

At the present time, the criteria development processes described in this document are intended to apply to freshwater and estuarine streams, bayous, rivers, and lakes, and do not apply to freshwater or estuarine wetlands or large rivers. Approaches for development and/or refinement of standards and criteria in wetlands are being developed separately.

## **II. Ecoregion (Reference Water body) Approach**

The premise of the ecoregional framework, as it relates to water quality and aquatic life, is that in the absence of human influences the water quality and aquatic life are more likely to be similar within an ecoregion than without, and that conditions in reference water bodies of an ecoregion represent the best attainable or “least impacted reference” conditions of most water bodies within that ecoregion. Therefore, the fish and wildlife propagation use and corresponding ecological conditions in “least impacted reference waters” are the basis for defining the DO criteria in specified ecoregions and water body types in Louisiana.

Louisiana’s ecoregion approach is defined by the following four activities:

### **A. Delineation**

Delineation of ecoregion boundaries began in Louisiana in 1990. LDEQ used EPA’s ecoregion map developed by Jim Omernik and refined the boundaries based on geographic information, reconnaissance of watersheds and best professional judgment. Data used to refine ecoregion boundaries in Louisiana included state soil associations, land uses, elevation, and hydrologic modifications. Louisiana has defined 12 ecoregions; boundaries may continue to be refined based on data analyses, including potential sub-regionalization. The recently completed EPA Level IV ecoregions will be evaluated and potentially used to assist with sub-regionalization of LDEQ’s twelve ecoregions.

### **B. Break-out of Water Body Types**

Louisiana is well known for its abundance of water bodies and, according to LDEQ’s most recent Integrated Report for 2006, contains over 66,294 miles of rivers and streams; 1,684 square miles of lakes and reservoirs; 9,191 square miles of fresh and tidal wetlands; and 7,656 square miles of estuaries. Louisiana lies entirely in the Gulf Coastal Plain physiographic province and can be divided into five natural physiographic regions: Coastal Marsh, Mississippi Alluvial Valley, Red River Valley, Terraces, and Hills. Maximum elevations in Louisiana are located in the hills of the northwest, where the state’s oldest geologic formations are found. The highest elevation in the state is only 535 feet at Mount Driskoll, Louisiana. The lowest elevations in the state are found in the Coastal Marsh area, which extends across the southern portion of Louisiana. Due to levee construction (e.g., Mississippi River), marsh filling, and a high rate of natural subsidence, portions of south Louisiana are below sea level.

Louisiana’s surface waters can be generally broken down into the water body types described above (i.e., rivers and streams, lakes, estuaries, etc.). Water bodies could also be generally classified as lotic (running water) or lentic (standing water) ecosystems. However, in Louisiana, the difference between lentic and lotic habitats is not always clear. For example, many of Louisiana’s rivers, streams and bayous have only a slight gradient with low (or zero) rates of flow and extensive floodplains. Louisiana’s lakes are generally shallow (less than 8 meters depth) and may be formed from river oxbows; there

are systems interconnecting both lentic and lotic habitats. Louisiana has also historically recognized that a large number of water bodies are characterized as “naturally dystrophic” because of certain natural hydrological or physical conditions (i.e., they contain high amounts of nutrients in the form of humic organic matter from allochthonous and other natural sources)<sup>1</sup>.

These natural characteristics coupled with historic hydrologic modification of the region (i.e., man-made water bodies, canals, etc.) demonstrate the need for continuing efforts to refine waterbody classifications. Currently, available data may not allow the development of DO criteria for all possible subcategories, therefore, for purposes of this document, water body types may be more generally classified according to representative characteristics of the ecoregion.

### **C. Reference (Least-impacted) Sites Selection**

A number of different tools are used to identify least impacted areas (see list below). The criteria listed below are used by LDEQ to select reference sites (in the different water body types) within each ecoregion. Watersheds that cross ecoregion boundaries will be evaluated to determine which ecoregion characteristics are predominant. During this process, LDEQ may choose to use other tools, such as EPA’s Level IV ecoregions, to define the reference site. If necessary, LDEQ may define subcoregions, which will be detailed in the resulting UAA reports.

1. Tools used to select reference sites:
  - Land use maps
  - Aerial photography
  - Satellite imagery
  - Point source inventories
  - Salinity maps and water body maps are studied to identify potential least impacted areas within LDEQ’s ecoregion delineations
  - Hydrological studies and local experts are consulted
  - Both on-the-ground and aerial reconnaissance surveys may be conducted
2. Reference Site Criteria
  - The entire watershed should be without any unusual or unique morphological or hydrological characteristics that are not exhibited by any other water body within the ecoregion
  - No significant point or nonpoint sources should discharge to or impact the water body. Examples of significant nonpoint sources could be agricultural activities, urban developments, silviculture activities, gravel mining, etc.

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<sup>1</sup> A review of the literature on dystrophic waters in Louisiana was conducted during 1986-87 to document the occurrence of this natural phenomenon (Day, et al (1987).” The report formed the basis of the rationale for the “naturally dystrophic waters” category of excepted uses previously described in LAC 33:IX.1109.

- The water body should be natural, preferably with no hydromodification.
- The water body should have a site that is accessible to the sampling crew
- The water body should be able to be sampled with gear of choice for ecoregion and water body type

#### **D. Site Characterization**

##### **1. Review of Existing Environmental Data and Information**

Extensive data mining exercises have been performed for LDEQ's ecoregion and UAA studies over the years. Experience has shown the following sources provide reliable data that may be usable for evaluating reference conditions, establishing appropriate DO criteria, and/or performing water quality assessments (Table 1). This list is not intended to imply that all data and information from the named sources will be used and/or evaluated, or that other sources of data should not be considered for use if available. The use of associated data, i.e. biological (fish), chemical (water quality) and physical (habitat) is essential.

**Table 1. Potential sources and types of data available.**

	Physical		Chemical		Biological	
	Geomorphology	Aquatic Life Habitat	DO	Temp	Fish	Benthic
<b>LDEQ</b>						
Ambient Water Quality Network			x	x		
Stream Surveys for Use Attainability Analyses	x	x	x	x	x	x
Stream Surveys for Total Maximum Daily Load Determinations	x	x	x	x		
Stream Surveys to Determine Dissolved Oxygen and Stream Slope Correlation	x		x	x		
Mercury Monitoring Network			x	x	x	
LDEQ Ecoregion Studies	x	x	x	x	x	x
<b>Louisiana Department of Wildlife and Fisheries (LDWF)</b>						
Marine Fisheries Independent Monitoring					x	
Inland Fisheries Independent Monitoring					x	
<b>U. S. Geological Surveys (USGS)</b>						
National Water Quality Assessment (NAWQA)			x	x		
NWISWeb			x	x		
<b>Louisiana State University</b>						
LDEQ/EPA supported studies	x	x	x	x	x	
<b>U. S. Corps of Engineers (USCOE)</b>						
Dredging/Channel Alterations	x					
<b>Local Governments (Parish and City Drainage/Levee Boards, etc.)</b>						
Dredging/Channel Alterations	x					
<b>Louisiana Department of Natural Resources (LDNR)</b>						
Coastal Use Permits	x					

## 2. Description of Physical Condition

Watershed sizes are determined using LDEQ's geographical information systems (Arc GIS). Watersheds can be categorized by sizes based on square miles. The size classes which were defined in the original ecoregion project for wadeable streams (LDEQ, 1996) are as follows:

- 0-25 square miles
- 25-100 square miles
- >100 square miles

As additional data is collected and analyzed, size classes may be further refined by ecoregion and will be reflected in the final UAA reports. In lotic systems, slope may also be a critical factor affecting chemical characteristics of the system. This effect may be less critical, however, in Louisiana southern and deltaic waterways because so much of the land has little or no slope. Slopes may be estimated from geographical information systems data or measured directly. Chemical data collected may be analyzed with slope, and any other hydrologic measurements to identify any key relationships (i.e. identified through statistical correlations) between the DO levels, biological condition, and flow.

Habitat assessments are conducted in all reference water bodies. LDEQ modified EPA's Rapid Bioassessment Protocol Low Gradient Stream Habitat Assessment form for use in Louisiana's upland/inland ecoregions (Appendix B). The form requires further modification to be more useful in the coastal areas of Louisiana; however, the existing form is currently used in both coastal and non-coastal areas for habitat characterization and to aid in the determination of water body conditions.

LDEQ's habitat assessment forms are used to assess the quality of several parameters (e.g., bottom substrate, pool bottom substrate, channel sinuosity, bank vegetative stability, streamside cover, riparian vegetative zone, bank stability, etc.) for scoring ranges or rankings of 'Poor', 'Very Poor', 'Fair', 'Good', and 'Excellent'. It should be noted that these rankings would be considered subjective as related to least impacted conditions. Therefore, the habitat assessment data is qualitative in nature but can be used to: 1) determine if a site is suitable as a reference area based upon the site selection criteria established in Section II.2; 2) relate DO concentrations to the physical properties of the reference site; and 3) ascertain the highest possible level of biological diversity given the constraints of the natural habitat. If any impact is noted (e.g. undocumented discharges, clear-cutting of riparian vegetation or other nonpoint source activities) on the habitat assessment forms, a location may be discounted as a reference site.

### 3. Determination of Chemical Condition

Continuous monitoring data (DO, temperature, pH, conductivity, percent saturation, and where appropriate, salinity) are collected in all reference water bodies. Minimum data requirements include:

- Collection months must include May through October at a minimum to identify seasonal DO fluctuations and the critical period - when levels of DO fall below the national benchmarks.
- Continuous monitors are deployed for approximately 72 hours each run to achieve the data quality goal of having 48 hours of data per run.

During the planning process for a given area, it may be determined that additional chemical constituents such as nutrients require monitoring. Minimum data requirements for describing chemical conditions other than the *in situ* monitoring described above will be documented in associated Quality Assurance Project Plan and final UAA reports. In some cases, data gaps may need to be addressed through the collection of additional data or by combining existing data that LDEQ has determined is representative of the reference condition. LDEQ will address limited data sets on a case by case basis, and work with EPA as necessary. If historical data is available for a selected reference site, that data will be evaluated for usability within the scope of the project. Historical data from other programs (e.g. ambient monitoring, mercury contaminant study) or other agencies may be utilized, as exhibited in Table 1 of this document. LDEQ will review each data set to determine its usability in terms of establishing reference conditions. Sites that have irregular DO-temperature relationships, super-saturation, or unusually high or low pH will be further investigated for possible impacts or sub-ecoregional differences.

### 4. Determination of Biological Condition

Biological data are collected, either directly by LDEQ or indirectly (e.g., through a contractor or another state expert or expert agency), for reference water bodies as determined by LDEQ. LDEQ will use fish data to characterize the aquatic community integrity. A single metric is not representative of the integrity, as a whole, of the biological community. Therefore, the biological data will be analyzed to identify key species, species richness, and total number of individuals. Diversity may be used as an optional measurement in freshwater lakes and flowing, freshwater streams, where it is typically a good indicator of biological condition. However, most methods of calculating diversity are biased against estuarine, open water environments, where some pelagic species of fish are found in large schools (i.e. large numbers of just a few species will skew diversity measurements).

Results will be evaluated to determine the aquatic community for each ecoregion and water body type in least impacted conditions. Once key species are identified, LDEQ may use expert consultants to establish spawning periods. If unexpected results occur, such as high counts of pollution-tolerant species, or if a particular reference site has results significantly different than similar sites (within the same ecoregion), that site may be reevaluated, though not necessarily or automatically excluded from use.

Louisiana's Department of Wildlife and Fisheries (LDWF) will be LDEQ's main source of indirect data. If LDWF Independent Fisheries data (Inland or Marine) are not available in selected reference water bodies, LDEQ will collect fish community data. LDEQ fish community sampling is conducted at least twice in each reference water body, once during the early part of the critical period and once during the non-critical period (see also Section II.3.c).

### **III. Criteria Development Procedures**

LDEQ is considering several options for dissolved oxygen criteria development (and is not settling on one method). However, this document presents the method for calculating a minimum dissolved oxygen criteria within an ecoregion framework. Other methods or modifications to the method that might be considered during the UAA studies will be detailed in the final UAA reports.

Minimum dissolved oxygen criteria will be based on the critical period, with a minimum criterion established for assessment. The first step for criteria development is to establish the critical period.

#### **A. Critical Period**

The critical period is the time frame in which high temperature, low flow (or no mixing) and low rainfall conditions allow the maximum extent of biochemical, oxygen-demanding activities to occur.

Historical data from ambient monitoring sites indicate that seasonal water temperatures are highest between the months of May and October<sup>2</sup> (typically > 20° C), but temporal patterns vary slightly across the state. Because DO concentrations are directly related to water temperature - the higher the temperature the less capacity to hold DO - the most severe oxygen depletions occur at these higher water temperatures. Spatial and temporal variations in rainfall and flow conditions also vary among ecoregions. The combined effects

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<sup>2</sup> Seasonal depletions during a given year are also related to the physiochemical, hydrological and geological characteristics. In naturally dystrophic water bodies, including those that are not wetlands, the low DO periods begin as early as March, while in others they may begin in May. Once established, the low DO conditions may last into October or even November (Day et al, 1987). Without representative historical data, the early part of the critical period is assumed to be April through June and the latter part is assumed to be July through October.

of these factors ultimately control both the reproductive seasons of resident biota and the “critical period” within any given ecoregion. In absence of other physical or ecological data that can be used to determine significant seasonality within a given ecoregion, LDEQ may choose to base the length and timing of the critical period on technical information provided in national guidance (USEPA, 1986).

Once established, the critical period would typically begin in the spring when DO falls below the determined threshold and end in the fall when DO rises above it. Dissolved oxygen data corresponding to the critical period in ecoregion reference sites will form the basis for calculating the minimum DO criteria.

The time frame representing the critical period as calculated above may be expanded if the critical period is not clearly depicted with the available dataset. Also, because seasonal criteria are intended to be protective at typically high seasonal temperatures for the appropriate taxonomic and life stage classifications (USEPA, 1986), the critical period for particular ecoregions may be adjusted based on data which adequately characterize life stages of resident communities. Without representative historical data, the critical period is assumed to be April through October.

Initially, biological and chemical data will be collected throughout the year (with a focus on spring and summer months) to obtain enough data to establish the critical period. Most waters in Louisiana (where historical data is available) have exhibited seasonal variations due to temperature changes. However, there may be some exceptions. These exceptions will be noted during the data analysis process used to set the critical period (see below). If no critical period is apparent, or if no significant seasonality is detected, then a year-round criterion will be proposed.

**Procedure to Determine Critical Period:**

- Aggregate reference stream continuous monitoring data (including DO, percent saturation, temperature, and pH) by ecoregion and water body type
- Graphically display data by month to establish when critical season begins for the water body type in that ecoregion
- Critical period begins when data points fall below the national benchmark
- Critical period ends when data points no longer fall below (end of critical period) the national benchmark

**B. Criterion**

1. Determine Critical Period (see above)
2. Determine Criteria

- Truncate the data set to exclude all data points not collected between 6 am and 12 pm, which is the typical time range in which to expect the DO minimum to occur in most waters.
- Assign critical/non-critical period (based on the critical periods defined in the above data analysis steps) to each data set
- Aggregate reference water body data (using Proc Means in SAS or other appropriate statistical analysis package) by ecoregion, water body type, and critical/non-critical period
- Calculate the 10<sup>th</sup> percentile of DO for each qualified dataset
- The lower of either the National benchmark value or the 10<sup>th</sup> percentile from the datasets becomes the criteria for each ecoregion, water body type and critical/non-critical period.

#### **IV. Assessment of DO Criteria**

LDEQ is developing an integrated monitoring and assessment approach to determine whether the attainment of the fish and wildlife propagation use is being met in all water bodies statewide. The approach integrates instantaneous dissolved oxygen grab samples and 24-hour continuous monitoring data, and can be applied in water bodies where seasonal-specific dissolved oxygen criteria have been developed for each Ecoregion and water body type. In areas of the state where these criteria are not yet developed, LDEQ may apply the assessment approach, but will use the previously adopted dissolved oxygen criteria of 5 mg/L for freshwater, 4 mg/L for estuarine areas, or other site-specific criteria as specified in the water quality standards regulations.

##### **Integrating Grab and Continuous Dissolved Oxygen Data Collection for Water Quality Assessment Purposes**

Grab sample data will be used for assessment of dissolved oxygen criteria. However, diurnal information obtained through continuous monitoring data may be utilized in assessment to validate or supersede a grab sample exceedance. Thus, continuous monitoring (CM) data must be at least as equally representative of the assessment period as profile (grab) data. For the purposes of dissolved oxygen assessment, the term “CM data” refers to deployment of a continuous dissolved oxygen monitor to gather representative ambient data for a period of 72 consecutive hours<sup>3</sup> at 15 minute intervals. The term “grab data” refers to a single discreet datum gathered during routine water sample collection associated with LDEQ’s Ambient Water Quality Monitoring Network (AWQMN). The greater value of CM data over grab data for assessment purposes is evident in the capture of three consecutive days (~10% of the represented month) of temporally-related data as compared to a single discreet datum (<0.1% of the represented

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<sup>3</sup> While the goal is to obtain 72 hours of data points, it is understood that field conditions, equipment malfunctions, and/or resource constraints might limit the actual number of data points obtained. In all cases where CM data is used for assessment, data will be used in 24 hour increments to capture complete diurnal cycles. Reasonableness will prevail in evaluating the data set for its use in attainment decisions.

month).<sup>4</sup> However, resource constraints prevent exclusive use of CM data for assessment purposes, necessitating the integration of more economically efficient grab data collections with the more definitive information obtained through continuous monitoring. LDEQ may choose not to expend resources necessary to validate or supersede grab data, and instead rely solely upon grab data for assessment purposes. While all grab data collected will be stored in LDEQ's water quality database, grab samples which were validated or superseded with CM data will be omitted from the assessment decision.

An assessment approach for dissolved oxygen that integrates grab data and CM data is detailed below:

1. During routine AWQMN data collection, monthly grab samples are collected at designated representative sites according to approved protocols to represent a sample month.
2. In the event that an exceedance of the minimum criterion is recorded during grab data collection, field staff would immediately (preferably within 48 hours but no longer than one week from grab data collection, provided that environmental conditions are similar to those experienced by the subject water body during grab data collection) deploy monitors for collection of CM data. CM data will be used to validate or supersede the subject sample month's grab data. If CM data collection does not occur, grab data values for the subject sample month will be used for assessment purposes if all other QA/QC checks out in accordance with approved protocols.
  - Each month's data collection, whether from grab sampling or CM sampling, represents a "pass or fail" determination.
  - Grab data that is above the minimum criterion represents a "pass" determination. Grab data that falls below the minimum criterion represents a "fail" determination.
  - The CM data set will be qualified and truncated to 72 hours (or other multiple of 24 hours, in the case of deployment errors or monitor failures that disqualify a large block of data) so that a full diurnal cycle is represented for the water body. Each data point in the qualified CM data set is a discrete point and will be compared against the criterion.
  - CM data would be assessed against the minimum criterion using the 10% rule; (i.e., if less than 10% of the total number of discrete data points within the CM data set representing a given sample month fall below the minimum criterion, the data set represents a "pass" determination. If more than 10% of the number of discrete data points within the CM data set representing a given sample month fall below the minimum criterion, the data set represents a "fail" determination).
  - To demonstrate the similarity between environmental conditions at the time of grab data collection and CM data collection periods, depth,

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<sup>4</sup> It is recognized that a time period containing 24 hours of CM data points is of greater value than single grab samples in making attainment decisions.

temperature, pH, and specific conductivity of the water body will be recorded and evaluated for comparability.

3. Use support determination will include monthly grab data and, when collected, CM data used to validate or supersede grab exceedances. For example, the 10% rule will be applied to the 12 monthly “pass/fail” determinations within a given sample year. If 11 determinations “pass” and 1 determination “fails”, the water body is supportive of the designated use(s) associated with the water body-specific dissolved oxygen criterion. If 10 (or fewer) determinations “pass” and 2 determinations “fail”, the water body is impaired for the designated use(s) associated with the water body-specific dissolved oxygen criterion.<sup>5</sup>

## **V. Water Quality Standards Rule Development, Promulgation and EPA Oversight**

LDEQ establishes its water quality standards as authorized in Section 2074.B (1) of the Louisiana Water Control Law (R.S. 30:2017-2078) and in conformity with Section 303(c) of the Clean Water Act (P.L. 92-500 as amended) and 48 FR 51405, November 8, 1983.

Once a water quality standard recommendation is developed, a series of administrative steps must be followed which are in accordance with the Administrative Procedure Act (APA) La. R.S. 49:950 et seq, the Environmental Quality Act, and LDEQ’s Rule Development procedures in order for the standard to be adopted into the state regulations.

As ecoregion/water body type DO criteria and biological conditions are determined, data and documentation outlined in this document will be compiled and submitted to EPA Region 6 for approval. The following paragraphs briefly outline the water quality standards rule development procedures and include the steps required to meet federal requirements.

### **A. Rule Authorization**

The Assistant Secretary (or the Undersecretary) of LDEQ, and the Deputy Secretary must approve an initial request to begin rulemaking.

### **B. Rule Development**

Once the draft language is developed, the LDEQ’s Regulations Development Section (RDS) will ensure the rule is formatted, in plain language, grammatically correct, etc. To begin rulemaking, the Fiscal and Economic Impact Statement (FEIS), and the Cost/Benefit analysis, if necessary, are also developed.

### **C. EPA and LDEQ Concurrence**

To help facilitate agreement between LDEQ and EPA that a water quality standards revision is approvable and can be implemented for Clean Water Act purposes, LDEQ

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<sup>5</sup> Ideally, there will be 12 monthly determinations. On some occasions, there may be more or less determinations. The 10% evaluation will be applied to whatever number of discreet data points are available for that site.

submits the draft standards revision rule and pertinent documentation to EPA for review. LDEQ also consults with the Louisiana Department of Wildlife and Fisheries (LDWF) and the US Fish and Wildlife Service during preparation of the draft revision. LDEQ and EPA-6 meets and/or corresponds to discuss issues informally; EPA-6 will discuss with EPA HQ and/or USFWS/NMFS as necessary. LDEQ will be provided with informal and then formal written comments. EPA-6 provides technical approval to LDEQ before LDEQ proceeds to the next stage.

#### **D. Draft and Proposal Stages**

LDEQ's RDS submits a Notice of Intent, the approved FEIS, and proposed rule to the Office of the State Register, members of the Legislative Oversight Committee (LOC), the Agriculture Commissioner, and Chancellor of LSU – Agriculture Center. At this time the Cost/Benefit report, if required, is submitted to the Joint Legislative Committee on the Budget for approval and to the Legislative Fiscal Office for review.

The Office of the State Register publishes the NOI, the FEIS, and the proposed rule in the *Louisiana Register*. The public notice, public comment period and the public hearing also occur during this stage. A LOC hearing is scheduled if necessary. LDEQ also publishes the proposed rule through its public website at:  
<http://www.deq.louisiana.gov/portal/tabid/96/Default.aspx>

#### **E. Final Stage**

The approved regulation is sent to the Office of the State Register for publication in the *Louisiana Register* and in the Louisiana Administrative Code. RDS publishes the rule in the Environmental Regulatory Code (updated quarterly) and on the LDEQ public website.

#### **F. EPA Oversight – Certification (40 CFR 131.6)**

Certification letter from LDEQ General Counsel to EPA-6 certifies that the water quality standards promulgation process was consistent with requirements in accordance with the APA.

#### **G. EPA Oversight – Approval/Disapproval (40 CFR 131.21)**

EPA provides approval (via letter or email followed by letter) within 60 days or disapproval within 90 days and notifies LDEQ accordingly. Because the process described here involves the revision of aquatic life criteria, and EPA is required to consult on either negative or beneficial effects on endangered species, concurrence from the USFWS and NMFS is necessary for final EPA approval of the proposed water quality standards and implementation for Clean Water Act purposes.

#### **H. Water Quality Management Plan (40 CFR 130.6)**

Revisions to the WQMP are drafted and reviewed internally by LDEQ, and a copy forwarded to EPA-6. Water quality standards implementation procedures are part of Louisiana's Water Quality Management Plan (WQMP), Volume 3. Revisions to the implementation procedures require that the documentation be public noticed consistent with the requirements of the APA and the Department's Water Quality Management Plan

(WQMP), Volume 1, Continuing Planning Process (CPP). If revisions to Volume 3 are in support of a proposed rule, this is usually accomplished concurrently with steps described in Sections C and D above.

Comments are received from all reviewers and are addressed in the plan as revisions or directly to the reviewer (i.e., by letter). The revised plan is published for public comment as specified in the Continuing Planning Process (CPP), Volume 1 of the WQMP. After all comments are received, they are addressed, and where appropriate, included in the final draft document. The final WQMP is then forwarded to the Secretary of LDEQ for certification (or designated Assistant Secretary). The document is then submitted to EPA for final approval, after which it is adopted by the LDEQ.

## Appendix A: References, Historical Data and Relevant Studies

The appendix contains summaries and other information about previous studies that may contribute data and information for LDEQ efforts to refine dissolved oxygen criteria and aquatic life use assessments.

**Arkansas DPCE.** 1987. Physical, Chemical, and Biological Characteristics of Least-Disturbed Reference Streams in Arkansas' Ecoregions, Volume 2: Data Analysis. ADEQ Water Division, 1987

During the Ecoregion study, streams (least-disturbed by man) which were generally typical of each Ecoregion and watershed size subcategory were intensively studied to determine their attainable uses. The attainable uses determined for the least-disturbed streams were then used to predict attainable uses for unsurveyed comparable streams which may be man-disturbed streams in the corresponding Ecoregion and watershed size category. As previously indicated, the Ecoregion study is essentially being used as a statewide UAA. We believe this provides an acceptable method for designating realistic attainable uses on a statewide basis given the infeasibility of surveying every stream. We believe it is acceptable for the State to qualify the decision to not designate fishable/swimmable uses in the critical period with a caveat that, should site-specific information become available for an unsurveyed stream which indicates a necessary modification in the attainable use designation, this information would be used in the public review process to modify standards."

Full reports can be accessed at:

[http://www.adeq.state.ar.us/water/branch\\_planning/publications.htm](http://www.adeq.state.ar.us/water/branch_planning/publications.htm)

**Crowe, Arthur and Bayer, Charles.** 2005. A Biological, Physical, and Chemical Survey of a Least-Impacted Watershed: Black Cypress Bayou (Creek), Texas, 1998-2005. Texas Commission on Environmental Quality

**Daigle, J.J., G.E. Griffith, J.M. Omernik, P.L. Faulkner, R.P. McCulloh, L.R. Handley, L.M. Smith, and S.S. Chapman.** 2006. Ecoregions of Louisiana. (2 sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA. Scale 1:1,000,000.

The project includes a refinement of level III and delineation of level IV ecoregions, providing a mechanism to further refine a waterbody classification system to describe natural differences in conditions across the state. For example, existing LDEQ reference sites in the Terrace Uplands may not represent attainable conditions in the southern part of the ecoregion.

**Dewalt, E.** 1995. Biological communities of reference streams in the South Central Plains and Upper Mississippi Alluvial Plains ecoregions. And: Dewalt, E. 1997. Fish and macroinvertebrate taxa richness, habitat quality, and in-situ water chemistry of ecoregion reference streams in the Western Gulf Coastal Plains and Terrace Upland ecoregions of southern Louisiana. Prepared for the Louisiana Department of Environmental Quality Office of Water Resources.

LDEQ studies document attainable conditions in four ecoregions using a suite of biological metrics and criteria derived from biological assemblages at confirmed, least disturbed

reference sites (non-reference quality sites were discarded during data evaluation). The criteria, derived from the quartiles of metric values from reference sites, were intended to identify “excellent” reference quality sites, any 303(d) listed waterbody that meets the “excellent” criteria is probably listed in error due to unattainable criteria.

**Gallant, A. L., T. R. Whittier, D. P. Larsen, J. M. Omernik, and R. M. Hughes.** 1989. Regionalization as a tool for managing environmental resources. EPA/600/3-89/060, 152 p.

#### **LDEQ Ambient Monitoring Network**

Existing LDEQ ambient monitoring data, collected during early morning critical periods and seasons, from stations on least disturbed reference water bodies could be used to establish criteria. Land use data should be analyzed to document least disturbed conditions, and biological collections should be analyzed to document comparability with other similarly sized reference water bodies.

**Louisiana Department of Environmental Quality.** In progress. Relationship between Nutrients, Dissolved Oxygen Conditions, Habitat, and Fish Assemblage Composition in Louisiana Streams. LDEQ-319 project

The data collected and subsequent analysis for the above mentioned study could provide LDEQ with all the necessary information needed to identify reference streams and describe the physical, chemical, and biological characteristics of water bodies in 4 different State ecoregions. The components of the study relevant to the UAA outline are briefly described below:

- One objective of the LSU study is to identify reference streams in four different ecoregions based on DO, fish, habitat and chemical parameters data. Once identified these reference streams could be compared to those that Dewalt identified to ensure only high quality sites are identified.
- The fish, habitat, and 24-hour DO measurements collected as part of this study would be sufficient to fulfill the biological description requirement discussed in the UAA outline. Metrics and thresholds similar to the ones formulated by Dewalt could be used to analyze the fish data and minimum DO criteria could be identified with the accompanying 24-hr diurnal measurements.
- Conventional parameters including, nutrients, temperature, pH, Chl-a, turbidity and others collected for this study would be sufficient if compiled with data from the LDEQ’s routine monitoring program. This information could be used to describe the chemical characteristics of the identified reference streams in each ecoregion. These chemical parameters would be discussed in the context of Louisiana’s water quality standards where applicable.
- The Habitat and flow measurements collected for the LSU study would be sufficient to describe the physical characteristics of streams in each ecoregion. Habitat and flow would help explain differences in aquatic community composition among streams in the same ecoregion.

A more appropriate ecoregion specific DO criteria could easily be formulated from the information collected as part of the LSU study and Dewalt’s previous work; provided the

analysis includes reference stream biological endpoints that show aquatic life use support tied to Dissolved Oxygen levels.

**Louisiana Department of Environmental Quality.** 1996. Quality Assurance Plan for Louisiana Ecoregion Project 104(b) Grant X-006647-01.

**Louisiana Department of Environmental Quality.** 1996. Use attainability analysis of the Ouachita River. Prepared for Office of Water Resources, Baton Rouge, LA. 49pp.

**Louisiana Department of Environmental Quality.** 1998. Use attainability analysis Mermentau River Basin: Bayou Nezpique, Bayou Plaquemine Brule, Bayou des Cannes, Mermentau River, Bayou Queue de Tortue, Bayou Lacassine. Office of Water Resources, Baton Rouge, LA. 47pp.

**Louisiana Department of Environmental Quality.** 1999. Use attainability analysis Vermilion-Teche Basin: Bayou Cocodrie/Cocodrie Lake, Bayou Boeuf, Chicot Lake, Bayou Courtableau. Office of Environmental Assessment, Baton Rouge, LA. 58pp.

**Louisiana Department of Environmental Quality.** In progress. Evaluation of Aquatic Life Uses and Dissolved Oxygen Criteria in the Terrebonne and Barataria Basins.

The project objective is to document the existing and attainable aquatic life uses and to evaluate supporting dissolved oxygen data in the Terrebonne/Barataria Basins and where appropriate, refine the uses and/or criteria. Water quality parameters used to assess fish and Wildlife Propagation use include dissolved oxygen, temperature, and pH.

**McLean, S.C.** 1992. Effects of timber harvesting activities on stream fish assemblages in Kisatchie National Forest, Louisiana. Masters Thesis. Louisiana State University, Louisiana. 61 pp.

Fish assemblage and physical habitat data collected from 40-sites in the Kisatchie National Forest may help to document attainable biological conditions by expanding the numbers of available reference sites and reference collections. Limitations: Some collections exhibit relatively small numbers of fish that may not adequately represent the populations (10 sites had counts greater than 200); and, some collections were made following recent clear-cuts.

**USEPA.** In progress. Assessment of Dissolved Oxygen, Physical Habitat and Biological Characteristics for Man-Made Canals and Unaltered Streams in the Terrebonne Basin, Louisiana. Information will be collected from reference sites three times during the year: summer, winter, and spring. Collectively the physical, chemical and biological data will be analyzed to characterize these bodies of water and to evaluate the dissolved oxygen levels that are possible in the Terrebonne Basin.

**USEPA.** 1972. Memo from Arthur W. Busch, Regional Administrator, to Rober A. Lafleur, Excecutive Director, Louisiana Stream Control Commission.

**USEPA.** 1983. *Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses*. Criteria and Standards Division, Washington, DC.

**USEPA.** 1986. *Quality Criteria for Water*. EPA 440/5-86-001.

**USEPA.** 2006. *The Wadeable Streams Assessment: A Collaborative Survey of the Nation's Streams*. EPA 841-B-06-002. As part of the wadeable stream survey data assessment, ORD developed reference stream screening criteria. A total of 334 reference sites were sampled during the survey, and ORD used the screening criteria to identify 1,291 additional reference sites from external data sets. The Coastal Plains criteria (level II ecoregion) for the low to medium threshold would be suitable for documenting reference conditions in Louisiana. The criteria were derived using data collected from reference streams in Louisiana and neighboring states.

**USGS.** In progress. Refinement of Aquatic Life Use Categories and Water Quality Criteria for the Western Gulf Coastal Plains Ecoregion of Louisiana. Region 6 Environmental Monitoring and Assessment Program.

Diurnal dissolved oxygen data, coupled with physical habitat data, and biological collections from nine reference quality sites ranging from wadeable streams to large non-wadeable rivers. Completion expected during 2008.

## APPENDIX B: Habitat Assessment Forms

LA, Parish: \_\_\_\_\_ Stream: \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_ Time: \_\_\_\_\_

Locality: \_\_\_\_\_

GPS Lat/Long: \_\_\_\_\_

Weather Conditions: \_\_\_\_\_

Predominate Surrounding Land Use (circle): Forest Field/Pasture Agriculture Residential Industrial Other: \_\_\_\_\_

Stream surface shading (foliar / nonfoliar) (circle): Open Partly Open Partly Shaded Shaded

Estimate of Percent Cover \_\_\_\_\_%

Dam Present (circle): Yes No Specify if manmade or natural (i.e. beaver dam): \_\_\_\_\_

Specify any dates or other markings on dams or bridges: \_\_\_\_\_

Channelized (circle): Yes No Specify if dredged or natural channelization present: \_\_\_\_\_

Access is provided by (circle): road trail park urban/suburban location beach boat ramp dock/raft bridge

Is access impaired by (circle if applicable): enclosure/fence private property

other: \_\_\_\_\_

Evidence of recreational use (circle): swimmers fishermen boaters rope swings fishing tackle

other: \_\_\_\_\_

Approximate the following:

Stream Width (m): \_\_\_\_\_, Stream Velocity (m/sec): \_\_\_\_\_, Riffle Depth (m): \_\_\_\_\_

Run Depth (m): \_\_\_\_\_, Pool Depth (m): \_\_\_\_\_, High Water Mark (m): \_\_\_\_\_

Water Quality (Do the following if a hydrolab is available for field/in-situ readings): Instrument used:

Temp (C): \_\_\_\_\_, DO2 \_\_\_\_\_, pH \_\_\_\_\_, Conductivity (µmhos/cm) \_\_\_\_\_, Other  
 \_\_\_\_\_, Battery \_\_\_\_\_

Inorganic Substrate Components

Organic Substrate Components

Substrate Type	% Composition	Substrate Type	Characteristics	% Composition
Gravel		Detritus	Sticks, wood, leaves (CPOM)	
Sand		Muck – Mud	Black, very fine organic (FPOM)	
Silt		Marl	Gray, shell fragments	
Clay		Other	Organic or Inorganic	

Habitat Assessment Field Data Sheet

Habitat Parameter	Excellent	Good	Fair	Poor	Very Poor
Bottom Substrate / Instream Cover	Abundant cover. Frequent submerged logs, snags, aquatic vegetation, and undercut banks	A good mix of submerged logs, snags, and instream and overhanging vegetation.	Some logs and snags and/or occasional areas of instream or overhanging vegetation.	Only slight cover. Stream is mostly cleared, with occasional snags and very little instream / overhanging vegetation.	Lack of habitat predominate. No cover, snags or vegetation. No undercut banks.
Circle ratings	19 18 17 16	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0
Comments					
Pool/ bottom substrate characterization	Mainly firm sand and/or gravel.	Mixture of soft sand, mud and/or clay.	All mud or clay.	All clay or mixture of silt and clay.	Top layer, all silt.
Circle ratings	19 18 17 16	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0
Comments					

Habitat Parameter	Excellent	Good	Fair	Poor	Very Poor
Channel Sinuosity (use a map & measure stream using a string, then divide by the straight line distance)	Greater then four times straight-line distance.	Three to four times straight-line distance.	Two to three times straight-line distance.	One to two times straight-line distance.	Channel straight, channelized waterway.
	14 13 12	11 10 9	8 7 6	5 4 3	2 1 0
Comments					
Bank vegetative stability	Over 90% of streambank surfaces covered by vegetation	80 – 90% of streambank surfaces covered by vegetation	65 – 80% of streambank surfaces covered by vegetation	50 – 65% of streambank surfaces covered by vegetation	Less then 50% of streambank surfaces covered by vegetation
	4	3	2	1	0
Comments					
Streamside cover	Dominant vegetation is a mixture of shrubs, trees and native vegetation	Dominant vegetation is of shrub form	Dominant vegetation is of tree form	Dominant vegetation is grass and forbes	Over 50% of streambank have no vegetation and is predominately soil, sand and/or concrete.

Habitat Parameter	Excellent	Good	Fair	Poor	Very Poor
	4	3	2	1	0
Comments					
1. Riparian vegetative zone width	Streamside vegetation on both sides > 50 m.	Streamside vegetation on both sides > 25 m.	Streamside cover on one side is > 10 m with the other side having at least 5 m of cover	Streamside cover on one side is > 10 m	Neither side has over 10 m of streamside cover
	4	3	2	1	0
Comments					
2. Bank stability	Stable, no signs of erosion, no undercutting of banks	Stable, spot erosion occurring infrequently, little undercutting of banks	Localized erosion evident, no continuous damage to bank structure	Unstable, extensive areas of bare banks, Significant erosion evident	Very unstable, over 50% of the banks have some form of erosion
	4	3	2	1	0
Comments					